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THE WORK OF THE UMATILLA RECLAMATION PROJECT EXPERIMENT FARM IN 1915 AND 1916.[1]

By R. W. ALLEN, *Farm Superintendent.*

INTRODUCTION.

The work of the Umatilla Experiment Farm is confined to experiments that are planned to solve the most important problems in connection with the production of crops on the sandy soils of the Umatilla Reclamation Project. Several reports have been made that show the progress of the investigations.[2]

Climatic conditions during the crop seasons of 1915 and 1916 were favorable for alfalfa, which is the most important crop, and also for most other crops that are being grown on the project.

During the period covered by this report, work was continued along the two general lines of soil improvement and the testing of varieties of fruit and other crops.

The soil improvement experiments include the use of commercial fertilizers, stable manure, green manures, and rotation of crops, to determine their influence on crop yields and the economical use of irrigation water. Interwoven with these are a number of irrigation experiments designed to show the approximate quantity of irrigation water needed, the extent of loss, and the chemical nature of the water lost by overirrigation; also the comparative value of different methods of applying irrigation water. These experiments are to be continued for indefinite periods, but have already given valuable results, which are discussed in this report.

[1] The Umatilla Experiment Farm is located on the Umatilla Reclamation Project, about 2 miles north of Hermiston, Oreg. The farm contains 40 acres of land withdrawn from entry in 1908 by the Department of the Interior for use as an experiment farm. It is maintained and operated by the Oregon Agricultural Experiment Station in cooperation with the Bureau of Plant Industry, United States Department of Agriculture, under a cooperative agreement. Operations were begun in 1909. The buildings used were constructed by the United States Reclamation Service and by the Oregon Agricultural Experiment Station. The expenses of the farm are shared equally by the Oregon station and the Office of Western Irrigation Agriculture. The investigational work is under the immediate supervision of a farm superintendent, who is a collaborator of the Bureau of Plant Industry.

[2] See Allen, R. W., "The Work of the Umatilla Experiment Farm in 1912," United States Department of Agriculture, Bureau of Plant Industry Circular 129, pp. 21–32, 1913; also "The Work of the Umatilla Reclamation Project Experiment Farm in 1913," an unnumbered circular of the Office of Western Irrigation Agriculture of the United States Department of Agriculture, issued Aug. 25, 1914; and "The Work of the Umatilla Reclamation Project Experiment Farm in 1914," Western Irrigation Agriculture Circular 1 of the United States Department of Agriculture, issued June 18, 1915.

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The variety tests of fruits have been continued for seven years and are beginning to produce definite results. Numerous varieties of legumes, corn, and crops of minor importance have been tried during the progress of the work on the farm. Most of them have not been reported upon until the present time, as the results were not sufficiently verified for publication.

TABLE I.—*Summary of climatological observations at the Umatilla Experiment Farm, 1912 to 1916, inclusive.*

PRECIPITATION (INCHES).

Year, etc.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Annual.
1912	2.22	0.67	0.49	0.61	1.25	0.97	0.05	1.18	0.10	0.29	0.54	0.13	8.50
1913	1.69	.57	.23	.34	1.72	.78	Tr.	.52	.16	1.43	1.20	.62	9.26
1914	1.82	.54	.03	.96	.59	.34	.15	Tr.	.52	1.06	.31	.49	6.80
1915	.73	.95	1.00	.71	1.52	.49	.74	.05	.09	.09	2.02	1.09	9.48
1916	1.40	2.45	1.55	1.07	.34	1.51	.78	.08	.03	.45	.....	.....	.....
Average	1.57	1.04	.66	.74	1.08	.82	.34	.37	.18	.66	.....	.....	.....

EVAPORATION (INCHES).

1912	(1)	(1)	(1)	3.98	5.21	7.51	8.23	5.68	3.87	2.98	0.78	0.25	38.50
1913	(1)	(1)	1.98	3.70	5.85	5.90	8.53	7.13	5.06	2.06	.70	(1)	40.90
1914	(1)	(1)	2.88	3.89	6.21	7.07	8.42	7.05	4.10	1.76	(1)	(1)	41.9
1915	(1)	(1)	2.34	4.52	5.24	9.18	9.20	7.11	4.72	2.70	1.37	(1)	46.38
1916	(1)	(1)	2.22	3.92	5.45	6.09	7.74	6.39	4.66	2.27	.....	.....	.....
Average	.....	.....	.....	4.00	5.59	7.15	8.42	6.67	4.48	2.35	.....	.....	.....

DAILY WIND VELOCITY (MILES PER HOUR).

Mean:													
1912	2.5	4.0	3.3	2.5	3.1	5.3	4.4	3.8	2.5	3.5	1.7	4.3	3.4
1913	3.1	2.5	4.7	5.2	3.7	4.5	3.8	3.0	2.2	2.3	2.1	1.2	3.3
1914	3.8	3.6	3.8	4.0	3.6	4.9	3.4	3.3	3.7	1.7	1.7	.98	3.2
1915	1.5	2.3	2.4	3.1	4.2	5.9	5.3	3.0	3.6	3.6	3.0	3.1	3.4
1916	3.0	2.2	4.4	4.4	4.8	3.7	4.4	2.7	2.9	1.6	.....	.....	.....
Maximum:													
1912	8.7	12.7	16.9	15.7	10.5	13.6	11.5	9.7	9.5	12.3	5.1	15.4	16.9
1913	15.3	6.9	13.9	14.2	11.8	9.8	11.9	7.0	8.2	8.3	11.5	3.3	15.3
1914	10.8	13.0	14.0	12.7	10.6	10.7	9.9	13.7	11.1	5.7	13.4	3.3	14.0
1915	8.6	7.5	6.5	10.4	11.1	11.3	12.1	8.5	10.6	11.5	8.0	12.4	12.4
1916	10.3	8.0	12.7	9.1	11.3	14.5	10.7	9.3	10.7	5.6	.....	.....	.....
Minimum:													
1912	1.2	.9	1.3	1.1	.9	.9	1.2	.8	.5	.6	.7	.5	.5
1913	.8	.5	1.0	1.4	1.1	1.3	.9	.5	.4	.4	.5	.3	.3
1914	.7	.8	.6	.8	.5	1.1	.9	.3	.2	.1	.1	.2	.5
1915	.2	.5	.3	.6	.7	1.5	1.7	.3	.8	.4	.4	.1	.1
1916	.4	.6	.1	1.1	.8	.9	.9	.3	.5	.2	.....	.....	.....

MONTHLY TEMPERATURE (° F.).

Mean:													
1912	29	40	41	52	61	69	72	69	59	48	42	35	.....
1913	30	23	45	53	59	68	74	83	60	50	43	31	.....
1914	39	37	47	51	61	66	74	73	61	53	42	26	.....
1915	30	41	49	55	60	67	73	76	62	55	41	34	.....
1916	17	32	47	52	55	64	69	71	62	49	.....	.....	.....
Maximum:													
1912	52	58	71	78	91	104	102	102	87	78	62	63	104
1913	66	60	64	86	87	97	105	103	91	81	65	51	105
1914	63	64	70	75	91	100	104	104	91	78	66	54	104
1915	48	59	74	84	87	95	103	104	91	78	62	61	104
1916	62	50	73	79	83	102	98	101	93	80	.....	.....	.....
Minimum:													
1912	−18	16	15	26	35	43	48	41	32	23	20	12	−18
1913	0	− 6	19	26	34	44	44	42	31	26	25	7	− 6
1914	21	12	20	26	33	35	44	42	37	31	22	− 4	− 4
1915	18	17	23	27	31	45	45	49	33	26	18	5	5
1916	−27	6	22	29	29	35	46	39	29	17	.....	.....	.....

[1] Record incomplete, owing to freezing of water.

CONDITIONS ON THE PROJECT.

CLIMATIC CONDITIONS.

Records of precipitation, evaporation, wind velocity, and temperature have been made at the experiment farm since September, 1911. This is done in cooperation with the Biophysical Laboratory of the Bureau of Plant Industry. The monthly averages of the climatological observations from 1912 to 1916, inclusive, are given in Table I.

The dates of the last spring frosts and first autumn frosts from 1909 to 1911, inclusive, were obtained from the local office of the Reclamation Service at Hermiston, about 2 miles from the experiment farm. From 1912 to 1916 the observations were made at the experiment farm. These data for the eight years, 1909 to 1916, inclusive, are given in Table II.

TABLE II.—*Killing frosts at Hermiston, Oreg., 1909 to 1916, inclusive.*

Year.	Last in spring.		First in autumn.		Frost-free period.
	Date.	Minimum temperature.	Date.	Minimum temperature.	
		°F.		°F.	*Days.*
1909	Apr. 21	27	Oct. 16	30	178
1910	Apr. 30	27	Oct. 15	31	168
1911	Apr. 20	31	Sept. 23	26	156
1912	Apr. 16	31	Oct. 6	31	173
1913	Apr. 23	28	Sept. 24	31	154
1914	Apr. 29	30	Oct. 20	31	174
1915	May 2	31	Oct. 5	30	156
1916	May 14	31	Sept. 28	29	138
Average					162

AGRICULTURAL CONDITIONS IN 1915.

In 1915 the total irrigable area of the 306 farms on the project was 9,698 acres, of which 5,306 acres were actually irrigated. The average irrigated area per farm was 17.3 acres. On the irrigated lands a total of 1,476 acres were occupied by nonbearing orchards and newly seeded alfalfa. The total area from which crops were harvested was 3,678 acres, which is 660 acres more than the crop-producing area in 1914. The average farm value per acre of all the crops on the project was estimated at $29.04, or slightly less than that of 1914, while the total farm value of the crops produced was estimated at $104,653. The acreage, yields, and farm values of the crops grown on the project in 1915 are stated in Table III, the figures being obtained from the United States Reclamation Service.

TABLE III.—*Acreage, yields, and farm values of crops produced on the Umatilla Reclamation Project in 1915.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Average per acre.
				Average.	Maximum.			
Alfalfa	2,396.8	Ton	9,141	3.8	8	8.07	$73,768	$30.78
Apples	53.5	Pound	16,400	306.7	6,000	.02	328	6.13
Barley	72.0	Bushel	1,900	26.4	80	.60	1,140	15.83
Clover hay	4.5	Ton	15.5	3.4	4	8.00	124	27.55
Corn	113.3	Bushel	3,778	33.3	109.7	.954	3,604	31.81
Corn fodder	67.2	Ton	252	3.8	10	3.69	930	13.84
Clover seed	2.0	Bushel	7	3.5	3.5	12.50	87	43.75
Garden	37.9						3,585	94.59
Hay, other	169.5	Ton	209.7	1.2	2	6.66	1,397	8.24
Melons	27.4	do	150	5.5	9	10.06	1,509	55.07
Onions	2.0	Bushel	470	235.0	320	.60	282	141.00
Peaches	130.6	Pound	276,800	2,119.4	12,000	.007	1,937	14.83
Pears	8.5	do	6,050	711.8	1,050	.03	181	21.35
Potatoes	55.4	Bushel	5,970	107.8	264	.61	3,642	65.57
Pasture	378.5						5,772	15.25
Small fruits	40.1	Pound	42,830	1,068.1	5,600	.049	2,099	50.12
Sorghum	10.3	Bushel	432	41.9	60	.766	331	32.12
Wheat	9.0	do	260	28.9	40	.80	208	23.11
Miscellaneous	99.5						3,729	37.49
Total	3,678.0						104,653	
Value per acre								29.04

The most noticeable feature of the agriculture of the project is the large proportion of land devoted to alfalfa, approximately two-thirds of the crop acreage. The growing season of 1915 was fairly favorable, and crop yields generally averaged about normal. The late spring frost damaged grapes and some other fruits in limited sections, but as a whole the fruit crop of the project was the largest yet produced, and prices were generally satisfactory, except that the market for peaches was dull. A large proportion of the alfalfa hay crop was sold early in the season at prices ranging from $7 in the stack to $11 per ton on the car. Much of the crop that was sold was baled or chopped to be shipped to distant markets. Although chopped alfalfa brings slightly less per ton than baled alfalfa hay, the practice of chopping is rapidly gaining favor among the farmers.

The early spring season was characterized by less windy weather and more frequent showers than have been usual in previous years, resulting in conditions more favorable for the early growth of crops. There was also rather less damage from insect pests than formerly, although there were several cases of injury from the ravages of the western army worm (*Chorizagrotis agrestis*). (See fig. 1.)

There was a slight increase in the number of the different kinds of live stock on the project, except in the case of hogs and fowls, the increase in the number of dairy cattle being particularly noticeable. The sales of dairy products, based upon figures furnished by the Hermiston creamery, show a monthly average of 6,820 pounds of

butter fat, at an average price of 27¾ cents a pound, representing an annual income of $22,710.60. It is estimated that during the year approximately 2,200 head of hogs were sold. Fifteen carloads were shipped from the project, having a value of approximately $18,400. There was relatively less feeding of range stock on the project in 1915 than formerly. The number and valuation of live stock on the Umatilla project from January 1 to December 31, 1915, are shown in Table IV, the figures being obtained from the United States Reclamation Service.

FIG. 1.—An old alfalfa field on the Baker tract, near Hermiston, Oreg., showing the ravages of western army worms on first spring growth. (Photographed April 22, 1915.)

TABLE IV.—*Number and value of live stock on the Umatilla Reclamation Project, January 1 and December 31, 1915.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increase or decrease in total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses	633	$87.37	$55,305	683	$86.14	$58,834	$3,529
Mules	26	128.65	3,345	42	112.98	4,745	1,400
Cattle:							
Dairy	641	61.09	39,160	765	57.80	44,217	5,057
Beef	206	51.07	10,520	258	27.29	7,041	−3,479
Sheep	42	5.38	226	113	5.13	580	354
Hogs	2,185	8.37	18,284	1,862	7.09	13,202	−5,082
Fowls	12,189	.635	7,735	11,608	.588	6,826	− 909
Bees (hives)	464	4.28	1,988	773	3.98	3,077	1,089
Total	.....	.....	136,563	.....	.....	138,522	1,959

AGRICULTURAL CONDITIONS IN 1916.

The rabbit pest, which has been increasing rapidly and causing serious damage to field crops, especially alfalfa, during the past few

years, was substantially checked during the winter of 1915–16. A vigorous poisoning and shooting campaign was pursued in the early winter and the number of animals was greatly reduced about the farm premises. The deep snows and cold weather of January and February so reduced the number of rabbits on the open prairie that crops were not appreciably injured by them during that year.

The temperature fell to 27° F. below zero in January and destroyed the peach crop by killing the fruit buds. Many of the trees were severely injured by the cold weather. Apricot trees, part of the pear and quince trees, and a few apple trees were also injured. The cool, backward spring permitted the injured trees to recover to a greater extent than would have been possible had warm weather occurred as early as it sometimes does.

A frost which occurred on May 13 and 14 severely damaged all varieties of grapes by killing the new growth. Some fruit which developed on the second growth, being late, was caught by frost on September 28.

The season was favorable for the growth of established alfalfa, corn, apples, and other crops except melons and crops similarly susceptible to injury from cool spring weather.

Approximately 80 acres of the project were planted to watermelons, but, owing to unfavorable climatic conditions and in some instances to the use of unsuitable land, the crop was very light. Four cars of melons were shipped and sold at prices ranging from $15 to $25 per ton. The quality of the melons was good, and the demand for them is growing in towns near by. The production of watermelons offers good opportunities to farmers of this district, and the partial failure of the 1916 crop should not be permitted to diminish interest in their production.

Eight and one-half carloads of apples were shipped from the project. Six cars went to eastern markets, and the remainder went in small quantities to local towns. Winesap, Rome Beauty, Jonathan, and King David were the principal varieties.

The crop of alfalfa hay was approximately 2,000 tons greater than in 1915. This is due both to an increase of about 400 acres of land devoted to alfalfa and to a general improvement in methods and efficiency in irrigation. The increase of $6 per acre in the estimated value of the crop is chiefly due to better prices. Alfalfa hay sold at $8 to $11 in the stack, and 232 cars of it were baled or chopped and shipped from Hermiston.

In the crop report following, the alfalfa stubble was considered as pasture and causes the acreage to be large and the value of pastures small.

The average farm value of $35.84 per acre for all crops in 1916, which is $6.80 greater than that of 1915 and $8.30 above the average

for 1912 to 1915, inclusive, is influenced largely by the high price of alfalfa hay. However, nearly all crops sold at higher prices than in previous years.

In 1916, 320 farms were operated, or 14 more than in 1915. The irrigable acreage of these farms was 10,229, of which 5,500 was actually irrigated.

The figures in Table V, which show the acreage, yields, and farm values of crops produced on the project in 1916, were obtained from the United States Reclamation Service.

TABLE V.—*Acreage, yields, and farm values of crops grown on the Umatilla Reclamation Project in 1916.*

Crop.	Area (acres).	Unit of yield.	Yield.			Farm value.		
			Total.	Per acre.		Per unit of yield.	Total.	Average per acre.
				Average.	Maximum.			
Alfalfa hay	2,985.3	Ton	11,412	3.8	7.9	$9.60	$109,555	$36.70
Alfalfa seed	8.5	Bushel	26.2	3.1	5.0	14.75	386	45.46
Apples	209.5	Pound	310,262	1,481	16,016	.023	7,136	34.06
Corn	100.8	Bushel	2,753	27.3	75	1.00	2,753	27.31
Corn fodder	100.0	Ton	322	3.2	15	4.54	1,461	14.62
Clover hay (red)	1.5	do	5.5	3.7		10.00	55	36.67
Clover seed (sweet)	20.0	Bushel	250	12.5	13	10.80	2,700	135.00
Cantaloupes	.5	Crate	50	100		1.15	57	115.00
Garden	20.5						2,775	135.37
Hay other than alfalfa	65.6	Ton	100	1.5	4.4	9.13	913	13.92
Miscellaneous	59.4						1,863	31.36
Onions	.8	Bushel	342	427.5	620	1.03	352	440.32
Peaches	30.3	do	No crop.					
Pears	7.5	do	do					
Potatoes	41.0	do	3,234	78.9	290	.92	2,975	72.57
Pasture	612.0						4,022	6.57
Small fruits	36.3						1,398	38.51
Vetch seed	2.0	Bushel	4.2	2.1		11.90	49	24.99
Watermelons	34.0	Ton	86	2.5	8	15.66	1,346	39.61
Total	3,900.2						139,791	
Value per acre								35.84

The number of horses, mules, beef cattle, hogs, and poultry has decreased during the past year. This is shown by the figures in Table VI, which were obtained from the United States Reclamation Service.

The decrease in the number of horses represents a surplus disposed of. Hogs diminished in numbers on account of the high price of grain, which rendered their production less profitable than other pursuits. Twelve cars of hogs were shipped by project farmers and brought approximately $18,000. Although the number of fowls decreased, their value increased, because there was a greater percentage of turkeys than formerly.

While the number of dairy cows remained practically unchanged, the valuation diminished, largely as a result of a better understanding being gained of their actual value. The local creamery, the out-

put of which represents the approximate production of the project, made 77,906 pounds of butter during the year. The price paid for butter fat was 25½ to 39 cents, the average being 29¾ cents a pound. This brought the farmers about $18,500.

The increase of about 4,000 head of sheep resulted from feeders being brought to the project.

An increase of 56 per cent in the number of stands of bees occurred during the year. An unusually heavy "honey flow" occurred, and 69,200 pounds of honey were harvested. It sold at prices ranging from 7 to 12½ cents a pound.

TABLE VI.—*Number and value of live stock on the Umatilla Reclamation Project, January 1 and December 31, 1916.*

Item.	Inventory, Jan. 1.			Inventory, Dec. 31.			Increase or decrease in total value.
	Number.	Value.	Total value.	Number.	Value.	Total value.	
Horses	683	$86.14	$58,834	571	$90.93	$51,921	—$6,913
Mules	42	112.98	4,745	39	111.28	4,340	— 405
Cattle:							
Beef	258	27.29	7,041	46	42.72	1,965	— 5,076
Dairy	765	57.80	44,217	737	52.74	38,870	— 5,347
Sheep	113	5.13	580	4,581	8.03	36,785	36,205
Goats (Angora)				50	5.00	250	250
Hogs	1,862	7.09	13,202	929	9.73	9,039	— 4,163
Fowls	11,608	.58	6,826	10,177	.73	7,521	695
Bees (hives)	773	3.98	3,077	1,210	5.00	6,050	2,973
Total			138,522			156,741	18,219

WORK OF THE EXPERIMENT FARM.

The investigational work of the Umatilla Experiment Farm deals with two important problems. One of these is the improvement of the soil, and the other is the testing of varieties of field crops, fruits, and vegetables. Some of the work of variety testing, particularly that of forage and green-manure crops, bears directly upon the problem of soil improvement, and this problem also involves matters relating to the movement of irrigation water over and through the soil. About three-fourths of the land available on the experiment farm has been put under irrigation and is used for the work discussed below. A plan of the farm showing the location of the experiments in 1915 is shown in figure 2. Figure 3 shows the location of the experiments in 1916.

SOIL IMPROVEMENT.

The soil of the Umatilla project is very sandy and porous and is not easy to irrigate or very productive at first. The problem of its improvement for crop production appears to involve two main points:

(1) To increase the fertility by adding such elements of plant food as are not present or available in sufficient quantities and to add

organic matter to the soil, so that the chemical and bacterial actions that take place in the process of its decay may tend to render available for plants such elements of fertility as are locked up in the soil.

(2) To prepare the land so that irrigation can be applied to it with the least loss of water and of soluble plant-food materials and to

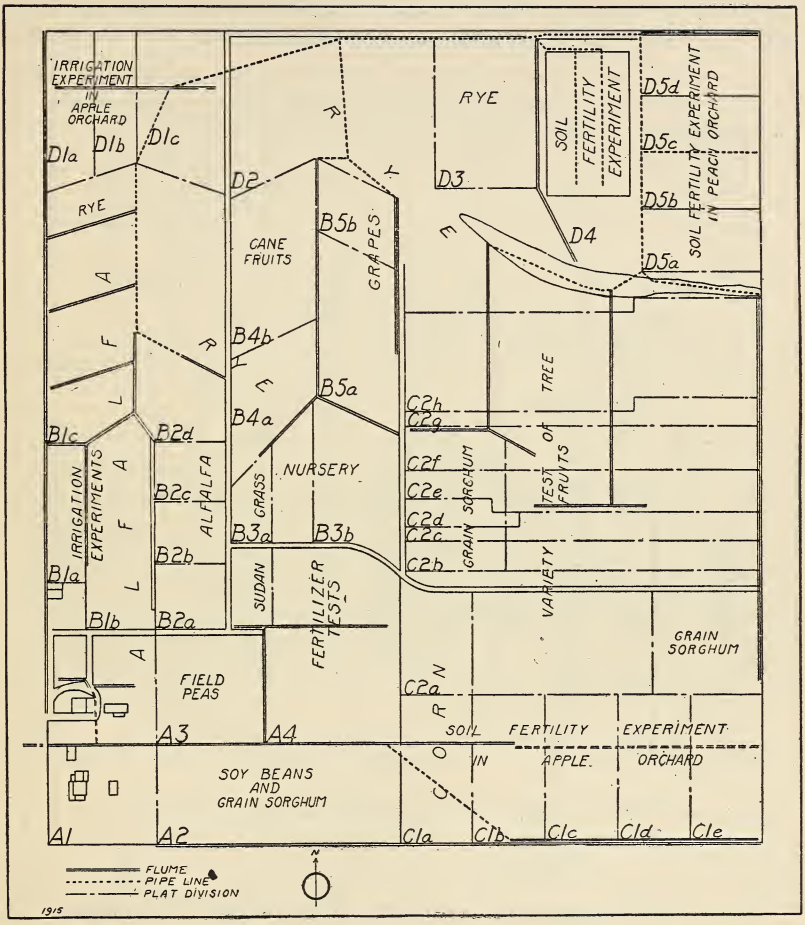

FIG. 2.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1915.

increase the water-holding capacity of the soil so as to diminish the waste of water and to permit less frequent irrigation.

COMMERCIAL FERTILIZERS.

This experiment comprises 18 tenth-acre plats in field A4. Light and heavy applications of the following fertilizers are made each

year: Nitrate of soda, muriate of potash, phosphate rock (phosphoric acid), lime, tankage, blood meal, and stable manure. It is desired to learn the influence of each of these materials upon crop production and to learn by comparison of crop yields which ones give the best results.

The land was made very uneven in character by the grading necessary to prepare it for irrigation. On this account it is impossible

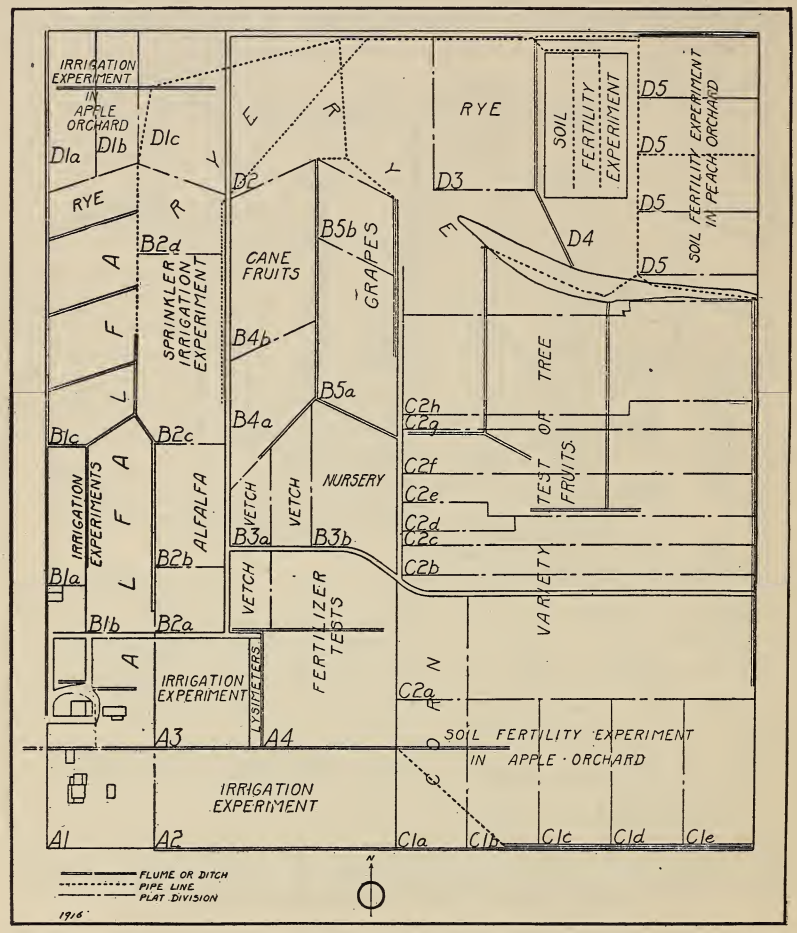

FIG. 3.—Diagram of the Umatilla Experiment Farm, showing the arrangement of the fields and the location of the experiments in 1916.

to compare one plat with another. To overcome this difficulty and to find the result of crop rotation on the various plats, a 4-year rotation was adopted. In this way the yields of each crop in the rotation on the respective plats can be determined by comparison with subsequent yields, as the work of the experiment progresses. The

plan of the rotation is clover two years, the last crop to be plowed under, followed by a winter green-manure crop of vetch; corn followed by vetch, and potatoes followed by a fall seeding of clover. This brings into the experiment two green-manure crops of vetch and one of clover during each rotation period. The fertilizers are applied each year in the amount shown in Table VII, which also gives the yields and calculated acre yields of clover for 1912, 1915, and 1916.

TABLE VII.—*Yields of clover in the fertilizer tests, Umatilla Experiment Farm, in 1912, 1915, and 1916.*

No. of plat.	Fertilizer.	Applied per acre.	Yield (pounds).								
			1912		1915			1916		
			First and second crops, per plat.	Total, per acre.	First crop, per plat.	Second crop, per plat.	Total, per acre.	First crop, per plat.	Second crop, per plat.	Total, per acre.
1	Nitrate of soda.....pounds..	100	349	3,490	65	22	870	285	259	5,440
2	.....do.....do....	250	370	3,700	40	37	770	352	319	6,710
3	Muriate of potash.....do....	150	342	3,420	15	5	200	331	259	5,900
4	.....do.....do....	300	327	3,270	18	6	240	207	199	4,060
5	Phosphate rock.....do....	150	518	5,180	38	12	500	342	259	6,010
6	.....do.....do....	300	709	7,090	54	34	880	465	339	8,040
7	Land plaster.....do....	50	604	6,040	34	50	840	331	299	6,300
8	.....do.....do....	150	726	7,260	98	52	1,500	444	319	7,630
9	Tankage.....do....	1,000	659	6,590	231	74	3,050	582	459	10,410
10	.....do.....do....	2,000	509	5,090	256	78	3,340	586	439	10,250
[a]11	Blood meal.....do....	300	454	4,540	76	50	1,260	403	279	6,820
12	.....do.....do....	600	313	3,130	235	140	3,750	1,200	489	16,890
13	Complete fertilizer.....do....	350	321	3,210	200	86	2,860	580	479	10,590
14	Same, plus lime.....do....	200	230	2,300	76	13	890	380	339	7,190
15	Manure.....loads..	10	231	2,310	81	20	1,010	410	329	7,390
16	.....do.....do....	20	319	3,190	181	49	2,300	445	399	8,440
[b]17	Check (no fertilizer).....	.....	.....	.....	91	35	1,260	460	419	8,790
[b]18	Check (no fertilizer; land kept idle and not irrigated).....	0	0	0	0	0	0	0	0	0

[a] A portion of this plat is encroached upon by a locust windbreak. [b] Plats 17 and 18 were added in 1914.

All plats produced more clover in 1916 than in 1912. The lightest increase in yield was in plats 7 and 8, to which land plaster is being applied. The greatest increase was on plats 12 and 13, receiving 600 pounds of blood meal and 350 pounds of complete fertilizer per acre, respectively. It is doubtful whether the increase in yield in these two plats is due in any great part to increased fertility of the soil resulting from the fertilizers. The land was not graded and is quite uniform, which makes this part of the field the easiest to irrigate thoroughly. The stand of clover on these two plats was especially good.

What appears to be the greatest gain that might be attributed to the fertilizers used occurred in plats 9 and 10, which received tankage at the rate of 1,000 and 2,000 pounds per acre, respectively.

This experiment did not progress well in 1915, when the second cycle of the rotation was begun. Clover was sown in the fall of 1914 and gave a good stand. It was destroyed by cutworms early the following spring and was resown in May. A poor stand resulted, and reseeding again became necessary in the fall. On account of the poor stand and slow growth of the clover, only two light crops of hay were harvested. The degree of success met with in getting a stand was much lower than in 1911, when clover was sown on the land for the first time.

Part of the crop shown in 1915 is rye sown with the first seeding of clover to prevent the soil from blowing. These data can not be used to advantage in interpreting the results of the experiment, on account of the irregularity of the stand of clover.

COVER CROPS AND ALFALFA IN APPLE ORCHARD.

Five plats in field C1, each containing approximately 0.75 of an acre, occupied by 32 apple trees, including 8 each of Winesap, Jonathan, Rome Beauty, and Esopus (*Spitzenburg*), constitute this experiment. The treatment given the plats is as follows:

Plat A.—Winter crop of vetch plowed under for green manure and followed by a cultivated crop. Corn has been used as the following cultivated crop.

Plat B.—Winter crop of vetch plowed under for green manure, followed by a summer leguminous crop to be used for the same purpose. No summer crop has been grown during the past three years.

Plat C.—Winter crop of rye plowed under for green manure, followed by clean tillage during the summer. Some manure has been applied to this plat.

Plat D.—Strips of alfalfa between the tree rows. The hay is removed and the land along the rows of trees cultivated to keep down weeds.

Plat E.—Solid stand of alfalfa from which the hay is removed.

Very little difference in the growth of the trees was observed on account of the seed being of poor quality. Plat B had a heavy growth of vetch and rye. The rye on plat C was large. A normal yield of about 5 tons per acre of alfalfa was secured from plats D and E.

Very little difference in the growth of the trees was observed on plats A, B, and C. They are doing better than plats D and E, the growth of which has been very slow. A decided improvement occurred in plat E in 1916, which resulted from the land being more thoroughly irrigated than in previous years. This was made possible by the use of borders with ridges in the rows of trees and by using a larger head of water than could be gotten to it before that year.

Only a very small amount of fruit was produced, the quantity being too small to consider in estimating the progress of the experiment.

No appreciable difference can be noted in the vigor of trees and general progress of the experiment between the years 1916 and 1915, except that of plat E already described. Three Rome Beauty trees in plats A and B were severely injured by cold weather which occurred in January, 1916.

In 1915, plats A and B had heavy crops of vetch plowed under and plat C a very heavy crop of rye. The trees grew well in all plats except plat E, where the competition of the alfalfa is quite strong and where insufficient irrigation was applied, on account of portions of the farm distribution system being too small. This difficulty has been overcome.

RAW LAND COMPARED WITH ALFALFA SOD FOR STARTING AN ORCHARD.

This experiment is planned to determine the comparative success of fruit trees planted on raw land and on alfalfa sod. It is also planned to continue it to determine the influence of green manure on orchards started with and without preparation of the soil. For this purpose the two original plats were each divided once and vetch started to be grown continuously on half of each.

Field D5, in which this experiment is being conducted, consists of four plats, A, B, C, and D, of approximately one-half acre each. The work was begun in 1911 when half the land, plats A and B, was planted to peach trees and the remainder to alfalfa. Four varieties of peaches—Alexander, Early Crawford, Elberta, and Hale—were planted. The rows of trees extend across the field in such a manner that each plat contains 8 trees of a variety, a total of 32 trees, excepting plat A, which has 40 trees, there being 10 of each variety.

The alfalfa in plats C and D was plowed up and peach trees set out in the spring of 1913. A crop of field peas was grown on these plats between the rows of young trees and plowed under in September. The entire field was sown to rye in the fall, with which vetch was sown on plats A and C. The ground was plowed in the spring, turning in the green crop, and resown again the next fall. The practice was repeated in 1915. Thereafter an annual crop of vetch is to be grown on plats A and C and rye on plats B and D.

The trees in plat B are the largest. They have the advantage of those in plat A, where the land was heavily graded. Development has been slow, and many of the trees are irregular in shape and small for their age. The trees planted on alfalfa sod two years later, plats C and D, are making a more rapid and more uniform growth than those started on raw land. This indicates that better success will be had by starting trees on alfalfa sod than on raw land. The growth of trees, however, does not indicate that two years' growth

of alfalfa, followed by plowing a crop of it in, improves the land sufficiently to produce trees of desirable vigor.

LYSIMETER INVESTIGATIONS.[1]

On the sandy soils of the Umatilla project the percolation loss of irrigation water is excessive. Large quantities of irrigation water must be applied in order to get it over the ground, and the soil retains only a small percentage of this water. These conditions make a study of the rate and amount of percolation and of the character of the percolate a matter of importance. It is important to know not only the quantity of water lost by percolation under the various crop conditions, but also the relation of the percolation to the movement of soluble material in the soil. With a view to securing information on these problems a set of lysimeter or drainage gauges have been installed.

The lysimeters are concrete pits 3.3 feet square (inside measurement), with an area of one four-thousandth of an acre, and 6 feet deep. They are constructed of oil-mixed concrete, to make them waterproof. Funnels extend through the floors to collect the percolate. The soil placed in the lysimeters was taken from field D2 in 6-inch layers and put into the lysimeters by layers in the same order and in as near the original density as possible. The soil is typical of the better grade of hill soils of the project.

Lysimeter No. 1 is not cropped, in order that the evaporation and percolation from the uncropped soil can be ascertained. Lysimeter No. 2 produces a crop of soy beans during the summer and a crop of hairy vetch during the winter. Both of these crops are turned into the soil at maturity, to increase the organic matter and plant-food content of the soil. Lysimeter No. 3 grows a crop of alfalfa, which is turned into the soil biennially and is reseeded to alfalfa the following spring. A cover of rye is grown during the intervening winter and turned under in the spring. Lysimeter No. 4 grows alfalfa continuously and has an application of manure at the rate of 32 tons per acre each fall.

The lysimeters are all irrigated with the same quantities of water. In 1915, 37 acre-inches were applied in 1½ acre-inch and 3 acre-inch irrigations. The precipitation was 1¾ inches from May 22, when the experiment was started, to the end of the year. In 1916, 47 acre-inches were applied in 1½, 2, and 3 acre-inch irrigations. The precipitation was 9.87 inches during the year. The results of this experiment are shown in Table VIII.

[1] This experiment was conducted by Mr. H. K. Dean, and this report was prepared by him.

TABLE VIII.—*Precipitation and irrigation, percolation, and evaporation and transpiration (in acre-inches) for all lysimeters at the Umatilla Experiment Farm in 1915*[1] *and 1916.*

Lysimeter.	Crop.	Precipitation and irrigation.		Percolation.				Evaporation and transpiration.			
				Inches.		Per cent.		Inches.		Per cent.	
		1915	1916	1915	1916	1915	1916	1915	1916	1915	1916
No. 1	No crop	38.75	56.87	26.041	44.565	67.2	78.3	12.709	12.305	32.8	21.7
No. 2	Soy beans and hairy vetch.	38.75	56.87	19.470	27.219	50.2	47.8	19.280	29.651	49.8	52.2
No. 3	Alfalfa	38.75	56.87	13.245	12.400	34.4	21.8	25.505	44.470	65.6	78.2
No. 4	Alfalfa (manured)	38.75	56.87	13.438	12.062	34.7	21.2	25.312	44.808	65.3	78.8

[1] The data for 1915 cover the period from May 22, when the experiment was started, to the end of the year.

The percolation from the lysimeter No. 1 (no crop) was highest for both years, with lysimeter No. 2 (soy bean and vetch) next, the two alfalfa lysimeters having the lowest percolation. The percolation from the two alfalfa lysimeters was practically equal each year. The evaporation from lysimeter No. 1 was practically the same for the two years. More water was evaporated and transpired from lysimeter No. 2 during 1916 than in 1915, probably on account of the vetch crop during the winter of 1915–16. More was evaporated and transpired from the alfalfa lysimeters in 1916 than in 1915, chiefly because the time included was longer and probably because the alfalfa made a better growth.

During the year 1916 both the irrigation water and the percolate were sampled and tested for solids, and the following salt constituents were found: Calcium (Ca), carbonates (CO_3), bicarbonates (HCO_3), chlorin, sulphates (SO_4), and nitrates (NO_3). In the case of total salts, the bicarbonates, chlorids, and sulphates, less was found in the percolate than had been added in the irrigation water. In the case of the calcium, carbonates, and nitrates, more was found in the percolates than had been added in the irrigation water. The most nitrates were leached from the lysimeter which grew soy beans and vetch, both crops of which were turned into the soil, and the lysimeter No. 1 (no crop) lost the next largest amount of nitrates. The loss of nitrates from the two lysimeters growing alfalfa was comparatively small.

The evaporation per one-week period from the lysimeter No. 1 averaged 0.677 of an acre-inch in 1915 and 0.583 of an acre-inch in 1916. The evaporation from the tank for the corresponding periods averaged 1.811 and 1.403 inches. The evaporation and transpiration from the lysimeter with soy beans in 1915 averaged 0.986 of an acre-inch per week and from the same lysimeter with soy beans and vetch in 1916 the evaporation and transpiration

were 1.307 inches per week. The evaporation and transpiration from the two alfalfa lysimeters in 1915 were comparatively constant throughout the season and averaged 1.323 acre-inches per week. The evaporation from the two alfalfa lysimeters in 1916 varied with the amount of water applied. When the 1½ acre-inch irrigations were applied the transpiration and evaporation averaged 1.509 acre-inches per week; when the 2 acre-inch irrigations were applied, 1.672 acre-inches; and when the 3 acre-inch irrigations were applied, 2.57 acre-inches. The variation was probably due to the fact that when the 1½ acre-inch and the 2 acre-inch applications were made the crop used practically all the moisture and received rather less than needed for the maximum growth, but when the 3 acre-inch applications were made the supply of moisture was greater than the crop used.

CROP-ROTATION EXPERIMENT.[1]

One of the principal limiting factors in the successful production of crops on the Umatilla project is the low organic-matter and plant-food content of the virgin soil. This experiment concerns methods of increasing the moisture-holding capacity of the soil and increasing the plant food available to the growing crops.

The organic matter and plant food of these sandy soils may be increased by applying barnyard manure, by growing green-manure crops, preferably as a winter crop, or by a combination of the two means. With these methods in view an experiment in which forage crops are grown in rotation with different combinations of barnyard manure and green-manure crops was started during the year 1915. The experiment has two definite objects: (1) To ascertain the effect of the combinations of crop, manure treatment, and cover crops on the yield of crops, and (2) to ascertain the effect of combinations of crops and manure treatment on the physical condition of the soil.

This experiment is located in field D4 on 36 plats of one-fortieth of an acre each. The following are the crop sequences: (1) Alfalfa grown continuously; (2) alfalfa grown two years, rye during the second winter, followed by feterita in the summer and rye the following winter, and then alfalfa for two years again; (3) feterita grown in the summer and rye in the winter; (4) feterita grown in the summer and hairy vetch in the winter. Each sequence has plats with no manure, plats with manure at the rate of 8 tons per acre, and plats with manure at the rate of 32 tons per acre. Each combination is carried in triplicate.

The plats are irrigated by an underground pipe system, the water being taken out at the stand pipes through portable hydrants to

[1] This experiment was conducted by Mr. H. K. Dean, and this report was prepared by him.

which are connected 12-foot lengths of canvas hose. The system has proved convenient and fairly economical of water. It was necessary to grade the plats for irrigation, and those in the first series were graded especially heavily.

Manure was applied in the spring of 1915 for the 1915 crop and in the fall of 1915 for the 1916 crop. The climatic conditions during 1915 were exceptionally favorable for starting the alfalfa and for the growth of feterita. The cold, backward season during the spring of 1916 was not favorable for the germination of the feterita, and hard winds cut the young plants badly.

The alfalfa during 1915 received an average of 6.34 acre-feet per acre of irrigation water; during 1916 it received 11.9 acre-feet per acre of irrigation water and 9.87 inches of rainfall. The feterita received an average of 4.54 acre-feet per acre of irrigation water during 1915 and 7.1 acre-feet per acre during 1916. The large amounts of irrigation water used for 1916 were due to the plats having been badly blown and washed. This was an excellent illustration of the necessity of keeping the land in the best condition possible for irrigation. The yields are shown in Table IX.

TABLE IX.—*Average production per acre of alfalfa, feterita fodder, and feterita grain on plats having no manure, 8 tons of manure, and 32 tons of manure per acre at the Umatilla Experiment Farm in 1915 and 1916.*

Crop.	Number of plats averaged.	Average yield per acre.						Increase of yield on account of manure.			
		No manure.		8 tons of manure.		32 tons of manure.		From 8 tons per acre.		From 32 tons per acre.	
		1915	1916	1915	1916	1915	1916	1915	1916	1915	1916
Alfalfa.....tons..	6	1.61	4.36	2.18	6.04	2.96	7.01	0.57	1.68	1.36	2.65
Feterita fodder...do....	6	1.85	.63	3.16	1.98	4.55	3.36	1.31	1.35	2.70	2.73
Feterita grain, bushels..	6	13.1	1.28	22.8	4.64	36.4	10.5	9.70	3.36	23.30	9.22

In 1915, the first year of the experiment, only two crops of alfalfa were cut. In 1916 the fourth crop in the alfalfa-feterita rotation was plowed under.

The applications of manure gave very pronounced increased yields of all crops, but the plats having manure at the rate of 8 tons per acre yielded more in proportion for the manure used than the plats having manure at the rate of 32 tons per acre.

In 1916 the 8 tons of manure increased the yield 1.68 tons of hay, which was at the rate of 0.21 of a ton of alfalfa per ton of manure, while the 32 tons of manure increased the yield 2.65 tons of hay, or at the rate of 0.083 of a ton of alfalfa per ton of manure. Valuing hay at $7 a ton, the manure applied at the rate of 8 tons per acre

was worth $1.47 per ton, and where applied at the rate of 32 tons per acre it was worth 58 cents per ton.

In 1915 the 8 tons of manure increased the yield of feterita grain 9.7 bushels, which was at the rate of 1.21 bushels per ton of manure while the 32 tons of manure increased the yield of feterita grain 23.3 bushels, or at the rate of 0.73 of a bushel per ton. Valuing feterita grain at 50 cents a bushel, the manure applied at the rate of 8 tons per acre was worth 61 cents a ton, and where the manure was applied at the rate of 32 tons per acre it was worth 36 cents a ton. The value in 1916 was approximately in the same proportion.

These values for manure show that with a limited quantity of manure available it is much more profitable to make light applications than heavy ones. As yet there has been no significant consistent change in the physical condition of the soil.

INFLUENCE OF THE FREQUENCY OF IRRIGATION ON THE YIELDS OF ALFALFA.

An experiment designed to show the influence of the frequency of irrigation on the yields of alfalfa has been conducted for three years on plats in field B1*b*. The results are similar for the entire period. A statement of the first year's results was made in the 1914 report,[1] but the data are here repeated for comparison with the results during the two subsequent years. The last two years' results differ only in that the largest yields per acre and per unit of water were obtained in 1916.

TABLE X.—*Irrigation intervals, number of irrigations, amount of water used, and yields of alfalfa hay in frequency-of-irrigation experiments, Umatilla Experiment Farm, in 1914, 1915, and 1916.*

Year.	Intervals between irrigations.	Number of irrigations.	Water used per acre.	Yield.	
				Per acre.	Per acre-foot of water.
	Weeks.		*Acre-feet.*	*Tons.*	*Tons.*
1914	3	8	4.40	4.00	0.92
	2	12	5.30	5.30	1.02
	1	24	9.70	5.57	.57
1915	3	7	2.33	3.50	1.50
	2	11	3.67	4.62	1.26
	1	21	7.00	5.67	.81
1916	3	7	2.33	4.25	1.82
	2	11	3.67	6.36	1.74
	1	21	7.00	6.72	.96

From the soil-moisture determinations that are made in connection with this experiment it was found in 1914 that the soil is capable of

[1] Allen, R. W. The work of the Umatilla Reclamation Proect Experiment Farm in 1914. U. S. Dept. of Agr., Bur. Plant Indus., West. Irrig. Agr. Cir. 1, 18 p., 3 fig. 1915.

holding against percolation only 4 inches of water in the surface 4 feet, the zone in which practically all the alfalfa roots are located. After this determination was made, 4 inches of water was applied at each irrigation. The intervals between irrigations, number of irrigations applied, amount of water used, and yields of hay obtained from the experiment for three years are shown in Table X.

A heavy rain occurred in June, 1916, and the entire season was cool. This, it appears, would have had a tendency to favor the plats less frequently irrigated. In comparing the 1916 yields with those of 1915, which was a very warm and dry season except for a rainy period in May, it is found that less difference exists between the yield of plats irrigated at intervals of three weeks than between those plats irrigated every week. These differences are shown in Table XI.

TABLE XI.—*Comparison of yields of alfalfa hay in frequency-of-irrigation experiments, Umatilla Experiment Farm, in 1915 and 1916.*

Intervals between irrigations.	Yield per acre.		Difference.	Yield per acre-foot of water.		Difference.
	1916	1915		1916	1915	
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Three weeks	4.25	3.50	0.75	1.82	1.50	0.32
Two weeks	6.36	4.62	1.34	1.74	1.26	.49
One week	6.72	5.67	1.02	.96	.81	.15

The pronounced increase in yield of the 1916 crop over that of 1915 can be accounted for only by the more favorable seasonal conditions.

The experiment shows the highest duty of water to result from irrigating alfalfa at intervals of three weeks, while the greatest return from the land comes from irrigating weekly. The amount of hay produced by weekly irrigations over that derived from biweekly irrigations averages but 0.56 of a ton for the three years and does not warrant the additional labor of applying the extra 10 irrigations and the $3\frac{1}{3}$ feet of water used. This excess labor and water are approximately sufficient to produce 4.76 tons of hay per acre when applied to other land. Biweekly irrigations are definitely shown to give the best results from the labor and water involved.

INFLUENCE OF THE FREQUENCY OF IRRIGATION ON THE GROWTH OF APPLE TREES.

An experiment was begun in field D1 in 1911 to determine the influence of irrigation at intervals of 7 and 14 days upon the growth of apple trees. All the trees have grown very slowly. At the end of the fifth year those most frequently irrigated averaged 3 feet in height and 4.1 feet in spread. Those irrigated every 14 days were

2.3 feet in spread and 3.5 feet high. In 1916 they did poorly. Vetch was sown among the trees on both plats in the fall of 1914 and again in 1915 and 1916. A thick stand had been established. It will be grown continuously and the irrigation continued according to the original plan to learn whether in connection with the use of the vetch the trees can be made to grow satisfactorily.

IRRIGATION BY BORDERS, OR SLOPING CHECKS.

Until recently furrow irrigation has been almost universally employed in this district, though a few farmers have used flat rectangular checks. Furrow irrigation requires much detailed work in regulating the many small streams of water and in making certain that it gets through all the furrows. When irrigation water is applied to coarse soil by means of furrows, uniform distribution of moisture does not result. When the land is flooded, as in irrigating checks, large heads of water are used with much less labor than in furrow irrigation, and the moisture is uniformly distributed through the soil if the irrigating is properly done.

A series of preliminary investigations to determine the manner in which irrigation water moves in coarse sandy soil showed that it went down very quickly in all instances and spread out to a very limited extent. In furrow irrigation it was found that when water was applied by means of furrows 2 feet apart it moved laterally through the soil so little that a portion of the soil to a depth of 6 feet between the furrows remained dry, although the water was run for several hours in the furrows. Water was run through shallow furrows 2 feet apart for 6 days in raw land without moistening the surface soil between them. It was then found that by flooding the land it could be uniformly moistened to depths which were determined by the quantity of water applied.

Level checks could not be irrigated successfully, because the water disappeared so rapidly near the box that much waste occurred unless very small checks were used, or else the head of water must be very large and so cover the ground quickly.

To avoid the expense of making numerous small rectangular checks having levees entirely surrounding them and to supply a means of spreading the water over the land, sloping checks, or borders, were brought into use with excellent results. Upon finding that border irrigation was so far superior to the methods in vogue, its use was recommended for all newly prepared or regraded fields that are not too steep. This method can be applied to all but a small portion of the Umatilla and neighboring projects. Furrow irrigation of row crops is probably the best on steep land that has been prepared so that the streams of water are carried in contour furrows having

moderate fall. Borders are not adapted to steep land where the excessive slope causes the soil to wash. The expense of grading becomes excessive and too much space is wasted in steep-sloping levees between the borders.

A high degree of economy in water and of labor can be attained by this method only by proper combination of slope of land, area of the borders, and head of water used.

An experiment was begun in 1916 to determine the influence of the length of the border on the amount of water required for successful irrigation with a given head. In field B2 three borders were made, 22 feet wide, 100, 175, and 250 feet long, and lettered *a*, *b*, *c*, respectively. The slope in each border is uniform and relatively similar in all of them, the total fall being 1.2 feet in *a*, 1.8 feet in *b*, and 1.9 feet in *c*. Twenty-one irrigations were applied during the season, using a head of water that varied from 1 to 1½ second-feet. The average time required to irrigate each plat, amount of water used, and the areas of the respective plats are shown in Table XII.

TABLE XII.—*Time of application and amount of water used in experiment in irrigating borders, or sloping checks, at the Umatilla Experiment Farm in 1916.*

Designation.	Length of border.	Area.	Average time of application.	Application per acre.	
				Total.	Average per irrigation.
	Feet.	*Acres.*	*Minutes.*	*Acre-feet.*	*Acre-feet.*
Border *a*	100	0.05	9.1	5.88	0.28
Border *b*	175	.088	15.3	5.87	.28
Border *c*	250	.126	32.8	8.50	.40

With this head of water and width of borders the 175-foot border is irrigated as economically as the 100-foot one. The 250-foot border is not as economically irrigated, but no more water was applied to it than the soil was capable of holding. However, some waste probably resulted from deep percolation near the upper end. With a larger head of water it might be irrigated satisfactorily, but 250 feet appears to be the maximum distance the water should be run under the best conditions found on these sandy soils. With a larger head of water, which should be used in general practice, the borders could be made much wider and the number correspondingly reduced.

Since the value of border irrigation for coarse soils was determined at the farm it has been very generally adopted throughout the district. Mr. Paul S. Jones, of the Office of Demonstrations on Reclamation Projects, working on the Umatilla project, has made a special effort during the past 1½ years to increase the use of this system of irrigation where it is practicable. On December 5, 1916,

he reported as follows regarding the extent to which it has been adopted: "There are 35 water users who are trying border irrigation in limited areas. Of these, three have tracts of 10 acres each, all in borders, and one man has more than 100 acres in borders. Other pieces vary from a fraction of an acre to 3 or 4 acres. Eight additional men expect to use borders on land they are preparing. Much of the land now in borders is not in first-class shape, but a beginning has been made, nevertheless."

VARIETY TESTS OF CROPS.

The tests of varieties of crops have been conducted along three general lines: (1) To determine the success and value of leguminous crops for soil improvement to be used for green manure or as forage for live stock; (2) to determine the success of kinds and varieties of fruits and vegetables for the home garden and for commercial production; (3) to select successful varieties of corn, sorghum, and other crops for supplementary feed for live stock.

CROPS FOR SOIL IMPROVEMENT.

Leguminous crops are valuable for use on light, open soil to increase its fertility and to improve its physical condition. A number of legumes appear to be well adapted to the raw lands of this district. Some of these crops are annuals and others are perennials. The perennial kinds are desirable for crop-rotation systems where they occupy the land two to six years or more and are followed by such crops as potatoes and corn. The annual crops are adapted to continuous use on orchard lands and as supplementary crops for late summer or winter seasons on land that might otherwise be idle. Alfalfa, red clover, and sweet clover are the most successful crops for use in definite systems of crop rotation. Sweet clover should be turned under at the close of the first or early in the second year. Red clover lasts three to four years and can be plowed under any time after it becomes full grown. Alfalfa can be turned under to advantage during the second year or later. Owing to the cost of starting it and its value as a hay crop, alfalfa should be left for six years or longer if the stand continues to be thick and the land remains smooth.

Similar precautions are necessary in starting all of the above-mentioned crops. Seeding should be done in the spring or fall, followed by frequent irrigation to prevent the seed and young plants from drying out. Land that is to be sown should be thoroughly protected from the wind by rye stubble, a thin stand of growing rye, or a covering of straw.

Soy beans, field peas, and hairy vetch are successful and desirable annual crops. The soy beans require warm weather and can be grown to advantage after early cash crops are removed from the land. The forage is good for hay or for green manure. Field peas require cool weather and make a good forage crop when planted in March or early in April. They are good for green manure, for hay, or for hog pasture. A late crop of sorghum or corn can be grown on the land after they are removed.

Hairy vetch grows well in the fall and spring and produces a good crop of green manure during the time garden land is idle between crops. It is valuable for this purpose and also for use in orchards, where it should be allowed to mature and to reseed the land each year. Methods of handling it have been discussed in the reports of the work of the Umatilla Experiment Farm in 1913 and 1914 and in Bulletin 120 of the Oregon Agricultural Experiment Station.

HARVESTING VETCH SEED.

A close study of the seed-bearing habits of the hairy vetch (*Vicia villosa*) has revealed definite possibilities of success in harvesting the seed, an operation heretofore considered impracticable in this dry climate. Hairy vetch produces an abundance of seed when not planted too thickly or when it is not overirrigated. Under normal conditions much of the seed is practically mature, although yet green in color, when the earliest pods begin to shatter. More seed is mature at this time than at any later period. If cut at this stage, or soon after, and handled carefully so as to minimize shattering and to save all the seed that does shatter, a large part of the crop can be collected.

When ready to harvest, the vetch should be cut with a mower. Each swath needs to be taken up before it is trampled by the horses. It should be placed in large shocks or windrows to cure, on canvas or burlap to catch the seed that shatters while it is drying. Persons having a floor or large canvas might place a layer 2 to 4 feet thick of the newly cut plants on this to cure. Additional layers of green material should be put on and cured as rapidly as possible until the entire crop is stacked, after which it can be thrashed at any convenient time. Small quantities of vetch can be flailed out to advantage.

The price of vetch seed renders its production a promising industry for this locality, for it can be harvested with a fair degree of success, and the methods of handling it doubtless can be greatly improved.

VARIETY TESTS OF LEGUMINOUS CROPS.

A considerable number of legumes have been tried to determine their value for green-manure purposes. The more extensive trials were made in 1914 and 1915.

SOY BEANS.

A test of six varieties of soy beans was made in 1915 in field A2. The seed, which includes some comparatively new sorts, was procured from the Office of Forage-Crop Investigations of the Bureau of Plant Industry. As the quantity received was very small, the rate at which it was sown was not noted. The seed was planted with a grain drill in which the alternate holes were stopped, making the rows of plants 1 foot apart. All varieties were sown May 14 and harvested September 25. Table XIII gives the names of the varieties and the yield of hay.

TABLE XIII.—*Yields of varieties of soy beans at the Umatilla Experiment Farm in 1915.*

Variety.	Yield per acre.	Degree of maturity.
	Pounds.	
Medium Yellow	4,823.5	About right for hay.
Auburn	4,654	Do.
Manchu	3,235	Do.
Black Eyebrow	1,059	Mature; seed ripe.
Ping Su	441	Do.
Ito San	323.5	Mature; seed almost ripe.

The calculated acre yields of the first three varieties are somewhat large, owing to the fact that the hay was not thoroughly cured when weighed. However, the excess of moisture in it was very slight.

Some varieties of soy beans, as shown in Table XIII, succeed very well. Their use should be confined to limited areas, however, as the seed is expensive and the product is very similar in food value to alfalfa, which is much the cheaper crop to raise. The greatest value of soy beans is for use on garden land following potatoes or other early crops or as a shade crop in orchards. They succeed best of all the annual crops so far tried that need to be grown in the summer.

Soy beans should not be put on land unprotected by a rabbit-proof fence, as rabbits are very fond of the young plants and will destroy large areas of them, even when other vegetation is more readily available.

FIELD PEAS.

Eight varieties of field peas were grown in 1915 in field A3. The land had been farmed for five years, but was not in good condition, as but a small amount of organic matter had been added to it. The seed of each variety, half of which was inoculated, was sown March 28. Prompt and uniform germination resulted in a good, even stand. At no time during the development of this crop could the slightest indication be found that the inoculated seed was doing any better than that which was not inoculated. The names of the varieties, date of harvesting for hay, and yields are shown in Table XIV.

TABLE XIV.—*Yields of field peas in variety tests at the Umatilla Experiment Farm in 1915.*

Variety.	Date cut for hay.	Average height of plants.[1]	Calculated yield of hay per acre.
		Inches.	*Pounds.*
Canadian	June 17	16	4,409
Bangalia	June 15	12	3,591
Clamart	...do....	12	3,591
Gray Winter	June 17	13	3,500
Cossack	...do....	14	2,954
Blackeye Marrowfat	...do....	14	2,818
White Marrowfat	June 15	11	1,818
Amraoti	...do....	13	1,375

[1] The average height of plants was measured at the time the first blossoms appeared, after which there was a slight increase in height.

The Canadian variety of field pea gave the best results and should be given slight preference, as seed of it is more readily obtained than that of other varieties. Bangalia, Clamart, and Gray Winter produced heavy crops and are desirable varieties. Peas should be more extensively used, especially for hogging off. This has been done successfully on the project and should be made a more common practice.

VETCH.

Besides hairy vetch, four varieties have been tried. They are the scarlet (*Vicia dasycarpa*, S. P. I. No. 32163), black-purple (*V. atropurpurea*, S. P. I. No. 1418), black bitter (*V. ervilia*, S. P. I. No. 34483), and common or spring vetch (*V. sativa*). Row tests of the first three were made in 1914 and 1915 and a number of plat tests were made of spring vetch in 1910, 1911, and 1912.

Scarlet vetch is hardy and produces an abundance of seed. It begins blossoming early and continues to blossom through a long period. On account of making a somewhat slower growth than hairy vetch it is hardly as desirable for cover-crop purposes. It is best adapted for use in orchards, where it should be allowed to mature each year and reseed the land.

Black-purple vetch did not become as large as either hairy or scarlet vetch. Part of the plants winterkilled, which was probably due to their large fall growth. This variety is much more hardy than black bitter vetch, but less hardy than hairy or scarlet vetch. It is more upright in habit of growth than either of these and does not stool out as much. It produces an abundance of seed, which is almost as large as that of the common vetch (*Vicia sativa*). The pods are long and well filled and do not shatter readily.

Two trials of black bitter vetch, both of which were under very favorable conditions, have proved unsuccessful. When sown in the fall it germinates readily and makes a strong growth. One lot was

sown on September 12, 1914, and the other on September 27, 1913. Both became well established before winter came on, but winterkilled badly. The few plants that survived made a weak growth in the spring and soon died.

Spring or common vetch has been tried a number of times without success. When sown in the fall it grew until cold weather, after which it soon died. It grew slowly when sown in the spring and ceased to advance when warm weather came on. It can not be used to advantage.

MINOR LEGUMINOUS CROPS.

Mammoth red clover.—This crop is very similar to the ordinary red clover. Plants of the Mammoth variety that stand alone tend to fall and spread out on the ground. Insufficient difference has been noted between it and the ordinary red clover to indicate that one is preferable to the other.

Alsike clover.—One trial was made in a nursery row in 1913. The plants grew slowly, but maintained a good color. Many blossoms were produced and a quantity of seed matured. It is hardy, but does not appear to be equal to red clover as a hay crop. It is desirable in pasture mixtures, as it springs up quickly after being grazed off.

Crimson clover.—Three trials have been made by spring planting and one in the fall, all without success. In each instance the seed bed was well prepared, and a uniform stand of plants was secured. After growing for a time the plants began to die. This continued until all were gone. The plants in a small patch that was sown May 15, 1913, died out gradually during the season. A few blossoms appeared on plants that were not more than 8 inches high.

Sainfoin (Onobrychis sativa).—A plat test was made in 1910 and a row test in 1913. A rather poor stand was secured in both trials. The growth was not sufficient in either case to render it promising as a fertilizer crop.

Bur clover and Japan clover.—Row tests were made by spring seeding in 1913. The plants grew slowly and did not become large enough to be used to advantage for green manure. A few bur clover plants did fairly well, from which it appears that this crop might be of value on improved land.

Fenugreek and lentils.—These crops were tested in rows in 1913 with only a fair degree of success. The growth was slow and many of the plants did not mature. A small amount of seed developed on the larger plants, which were not more than 8 inches high. Their growth is insufficient to render them of value for soil improvement.

Cowpeas and horse beans.—Row tests of these crops made in 1913 indicate that they are of little value, on account of their small size and the death of many of the young plants. The horse beans reached

a maximum height of 14 inches and blossomed, but did not produce seed. A number of the cowpeas produced seed, but the plants were very small.

Velvet beans.—From the row test made in 1913 these were found to do fairly well. A few of the plants attained desirable size, but most of them died or became dwarfed while quite small. They probably would do fairly well as a summer crop on improved land.

VARIETY TESTS OF FRUITS.

A total of 293 varieties of tree fruits, grapes, and cane fruits are under trial to determine their adaptability and value for use in this district. The number is divided as follows: Apples, 47; pears, 15, including the Japanese sand pear; quinces, 7; plums and prunes, including the American wild plum (*Prunus americana*), 27; cherries, 26, including the sand cherry (*Prunus pumila*); nectarines, 4; apricots, 13; peaches, 50; grapes, 55; cane fruits, 49. The tree fruits are in field C2, grapes in B5, and cane fruits in field B4.

Seventy-five varieties of strawberries and 86 varieties or species of forest and ornamental plants have been tried and reported upon.[1]

Many of the varieties of fruits were injured by the cold weather which occurred in January, 1916. Of the apples, the Rome Beauty suffered most seriously. Pears, quinces, nectarines, apricots, and peaches were injured to some extent. The plums, prunes, and cherries sustained very slight injury. Grapes were not seriously injured by the winter, but were badly injured by a frost which occurred on May 14.

A number of varieties, except of peaches and nectarines, bore fruit. The season's growth was about as strong as usual, but started late on many trees. The growth of the trees in this experiment is very irregular, on account of soil conditions and cultural treatment. The presence of vetch in one portion of the orchard has made an improvement in the vigor of the trees during the past two years. Vetch is now established in the orchard and will be kept there continuously until the trees become vigorous and indicate overstimulation, should such a condition occur.

APPLES.

Of the 47 varieties of apples, 22 blossomed and bore fruit in 1916. The early varieties, such as Yellow Transparent and Oldenburg, are

[1] Allen, R. W. The culture of small fruits on irrigated sandy land. Oreg. Exp. Sta. Bul. 142, 14 p., 2 fig. 1917.

Allen, R. W. Windbreaks, hedges, and ornamentals for irrigated sandy soils of eastern Oregon. Oreg. Exp. Sta. Bul. 125, 25 p., 12 fig. 1915.

Allen, R. W. The work of the Umatilla Reclamation Project Experiment Farm in 1913. U. S. Dept. Agr., Bur. Plant Indus., West Irrig. Agr. Cir. [B. P. I. Doc. 1078]; 14 p., 4 fig. 1914.

Allen, R. W. The work of the Umatilla Reclamation Project Experiment Farm in 1914. U. S. Dept. Agr., Bur. Plant Indus., West Irrig. Cir. 1, 18 p., 3 fig. 1915.

promising on account of their abundant yields and the early maturity of the fruit. Such varieties as Alexander, Early Goodwin, Orenco, Wealthy, and Akin are not altogether promising. They are too late for the summer trade and too early to be disposed of to advantage on the winter market. The Orenco is very irregular in shape and size and falls badly before it is fully mature. The standard winter varieties, Jonathan, Rome Beauty, and Winesap, colored well and matured late enough to be marketed to advantage. Of the crab apples, all of which fruited, the Hyslop appears to be by far the most desirable. It matures and keeps well, while the Siberian, Martha, and other varieties keep but a short time.

PEARS.

Most of the varieties of pears were seriously injured by the extremely low temperature of 27° F. below zero which occurred in January, 1916. The fruit buds and many leaf buds were killed and much of the wood became discolored. Growth began later than usual in the spring and was very irregularly distributed over the trees. Soon after active growth began the discoloration of the wood and bark disappeared to a large extent. The trees grew fairly well and finally appeared to recover entirely from the winter injury. A few Bartlett fruits developed from blossoms that appeared on new growth and matured in September. Seven varieties blossomed in 1915, but none fruited, on account of late frost. The growth, although slow, was as good as it had been in previous years. A few trees in moist locations grew rapidly.

QUINCES.

Some quince varieties, particularly the Champion, Pineapple, and Smyrna, suffered severe winter injury. The Rea and Apple are small and are growing slowly. The Smyrna and Champion are large and vigorous. All varieties blossomed between April 27 and May 3, 1916. Much of the fruit was killed by frost on May 14. Some of it which appeared soon after the frost to be seriously injured matured in good condition, while the fruit of other varieties which did not appear to be seriously injured fell off.

All the varieties blossomed in 1915, but none fruited, on account of frost. Fair growth was made. The tendency of quince trees to become bushy by throwing out numerous suckers from the larger branches and to put up strong new growth from near the ground is difficult to overcome.

PRUNES AND PLUMS.

Most all the varieties of prunes and plums blossomed and fruited in 1916. The most promising varieties are Agen (*Petite, French*), Sergeant, Sugar, Bradshaw, and Hungarian. The trees of the last

named are not strong under the conditions where grown. The Agen (*Petite, French*), and Sergeant grow vigorously and produce heavy crops of fruit of superior quality. Very slight winter injury was sustained by a few of the weaker trees, and the fruit of some varieties was thinned to a limited extent by the frost.

The growth of the trees this year was very similar to that which occurred in 1915, the strongest varieties being Agen (*Petite, French*), Sergeant, Peach, and Maynard. Several varieties blossomed in 1915, but none fruited except Abundance, one tree of which bore a light crop. The loss was due to a severe frost which occurred April 20, soon after the fruit had set.

TABLE XV.—*List of varieties of peaches grown on the Umatilla Experiment Farm, showing size of the tree, date of blooming, and date of ripening fruit in 1915.*

Variety.	Date of blooming.	Date of ripening.	Average size of tree (feet).	
			Height.	Width.
Alexander	Apr. 2		6.8	7.7
Arp	do		5.0	4.0
Australian Saucer	Apr. 1		7.0	6.5
Belle	Mar. 28		5.8	4.0
Bilyeu	Mar. 26		8.4	6.7
Briggs	Mar. 31		8.5	10.5
Carman	Mar. 28		7.8	7.5
Champion	Mar. 29		6.5	6.2
Chinese Cling	Mar. 28		6.8	5.8
Columbia	Mar. 26		6.3	6.5
Crosby	Apr. 2	Aug. 26	8.3	8.7
Dewey	Mar. 26		8.2	7.8
Early Crawford	Apr. 4		7.0	7.0
Early Hale	Mar. 29		7.0	7.1
Early Imperial	Mar. 26		4.5	3.6
Elberta	Mar. 29	Aug. 13	11.8	8.2
Fitzgerald	do		8.7	5.3
Foster	Mar. 30		5.5	5.0
Globe	Mar. 29	Aug. 2	11.3	9.3
Greensboro	do		5.2	5.7
Heath	do		7.1	6.3
Late Crawford			6.3	4.6
Late George	Mar. 29		9.0	8.8
Levis Cling	Mar. 30	Aug. 26	5.5	5.3
Levy			6.2	6.5
Lovell	Mar. 29		6.0	3.2
McDevitt	do		4.8	3.3
McKevitt			4.0	2.5
Morris White	Apr. 2		7.2	5.7
Mountain Rose	Mar. 29		4.2	3.5
Muir	do	Aug. 26	6.3	4.3
Opulent	do	Aug. 13	8.2	7.8
Perfection	Apr. 2	Aug. 26	9.0	11.2
Persian Cling	Mar. 29		6.8	5.2
Phillips	do		10.5	10.0
Picquet	do		5.0	4.0
Runyon	Mar. 27		6.5	6.2
St. John	Mar. 28		5.5	5.2
Salway	Mar. 29	Sept. 23	6.7	7.7
Sellers	Apr. 2	Sept. 7	6.8	5.5
Sims Cling			5.7	5.0
Sneed	Mar. 29		4.1	4.0
Strawberry	do		5.3	7.3
Susquehanna			4.3	3.1
Triumph	Mar. 29	July 15	6.7	4.7
Tuskena	do		6.2	6.0
Van Buren Dwarf	Mar. 24	Aug. 26	3.2	3.8
Wheatland	Apr. 2		8.1	7.7
Webber's Prize	Mar. 29		6.7	5.2

PEACHES.

The entire crop of fruit buds and many leaf buds of peaches were killed by the cold weather in January, 1916. Much of the wood of the trees was discolored; some bark and many of the smaller branches and some of the larger ones were killed. The Australian Saucer, a rather vigorous-growing variety, was entirely killed. The dwarf St. John was killed back almost to the ground, but made a slight growth late in the season. Two early varieties, Alexander and Triumph, appeared to be the most hardy, as they were but slightly injured.

On account of the difficulty in determining the extent of the winter injury, pruning was postponed until after the new growth appeared. On June 6 the trees were severely pruned by cutting the branches back to where vigorous new growth had started and removing such of them as were very weak or dead.

In 1915 all but 5 of the varieties blossomed and 10 of them bore fruit. Serious loss occurred from frost. The average size of the trees of each variety, most of which were 6 years old, the date of blooming, and the date the fruit matured are shown in Table XV.

On account of the early warm weather, the blossoms appeared earlier than usual. The size of the trees, as shown by measurements taken at the close of the sixth year's growth, indicates that they are very small for their age. This is due in part to their being on new land which is steep and on a southern exposure where conditions are not altogether congenial. The range in size of trees of the different varieties is largely due to irregularity in soil conditions resulting from grading.

NECTARINES.

The extent of winter injury of nectarines was very similar to that sustained by peaches. The Stanwick appeared to be the least affected of any. No blossoms appeared in 1916, and the trees were pruned back in similar manner to the peaches. In 1915 the Boston and Stanwick blossomed, but produced no fruit. The average size of the trees was 6 feet in height and 5 feet in spread. The growth is uniform and sturdy, but short.

APRICOTS.

Contrary to the general opinion that apricots are less hardy than peaches, the blossom buds were not all killed by the winter weather which destroyed the entire 1916 crop of peaches. Most varieties blossomed, although lightly, and produced a fair crop of fruit after being thinned by late frost. Although the injury to the trees did not appear to be as great early in the season as that of peaches, several trees and numerous large branches died during the summer. Many buds and spurs were destroyed, especially on the older wood.

In 1915 ten varieties blossomed between March 21 and 24. The fruit was destroyed by frost after it had reached an average length of about five-eighths of an inch. Some varieties grew strongly, others slowly. Newcastle is the smallest of the trees. Its average is 3.7 feet in height by 2.5 feet in spread. The Tilton averages 13 feet in height and 12 feet in spread. Hemskirk and Budd are also vigorous and hardy. The range in size and vigor of trees is influenced to some extent by soil conditions, but is largely the result of varietal characteristics.

GRAPES.

The injury to grapes from low temperatures in January, 1916, was not more serious than in mild winters, because the plants were covered with snow. The spring was cool, and growth appeared later than usual. The new growth was killed back on May 14, at a time when many blossoms were appearing. The influence of frost was general at this time, killing all the green wood and blossoms.

Promptly after this frost, new growth was put out, and 21 varieties bore fruit, although it was late, undersized, and in small, irregularly shaped bunches. The Sweetwater did especially well, the eight plants producing 142 pounds of fruit which was almost normal in size. It did not fully mature, and was injured by frost on September 20. Unlike previous years, the Viniferas bore more fruit than the American varieties. The Black Hamburg and several American varieties reached full maturity, but all late varieties were caught by the fall frost. The growth was generally small. The plants appear to be much weakened by the severe injury caused by the late frosts in 1915 and 1916.

On April 20, 1915, at a time when the new growth had started and blossoms were opening, all the varieties of grapes were severely frozen. After this, 20 varieties blossomed again and produced fruit. The Diamond, Campbell, Worden, and Sweetheart varieties produced the most fruit. The Salem appeared to be the most vigorous variety. Early Ohio, McPike, and Winchell made a very weak growth and produced little fruit.

The ground that was planted to Moore and Concord, with which no success was had, was planted to new varieties as follows: Brilliant, Cynthiana, Cottage, Dutchess, Early Daisy, Elvira, Empire State, Fern Munson, Goethe, Herbemont, Herbert, Ives, Janesville, Jessica, Lady, Martha, Muench, Norton Virginia, Regal, Rommel, Triumph, Ulster, Vergennes, Wilder, and W. B. Munson. Although these small plants were injured by frost and the summer was warm, many of them made a fair growth.

Vetch was planted in the grape vineyard in the fall, to be used as a green manure and also to shade the ground during the summer.

The severe winter temperature injured a number of blackberries, especially the Mammoth. The Himalaya, Loganberry, and Phenomenal were no more seriously injured than in previous winters, as the bushes were protected by the snow. Dewberries sustained very slight injury where exposed above the snow. Raspberries appear to have been uninjured.

The varieties of blackberries that appear to be most successful are Lawton, Wilson, Kittatinny, and Mersereau. Lucretia dewberries, Munger and Kansas raspberries, and Oregon and Smith gooseberries are good varieties. The Phenomenal, Loganberry, Himalaya, and Mammoth blackberries grow with fair vigor but are not desirable, as they produce only small crops of fruit.

The performance of the different varieties of cane fruits in 1915 was normal. The growth was slow, but rather robust in appearance. Blackberries did fairly well and dewberries very well, but the fruit was seriously injured by warm, dry winds which prevailed at the time when it was maturing. The injury to exposed fruit by drying is usually extensive and renders the production of cane fruits rather hazardous.

VEGETABLES.

No work was done with vegetables in 1916. The 1915 work was limited to variety tests of watermelons and muskmelons. These tests were conducted to verify the success of promising varieties previously grown. The result was that the superior value of the Kleckley Sweet (*Monte Cristo*) watermelon for home and market use, and of the Hoodoo, Petoskey, Hackensack, and Emerald Gem muskmelons was borne out quite strongly. These varieties have produced superior melons, although in lesser quantities than some other varieties, in several tests and are valuable for this district.

Numerous kinds and varieties of vegetables have been tried under a wide range of cultural conditions and reported upon.[1]

CORN AND GRAIN-SORGHUM VARIETIES.

A number of varieties of corn and grain sorghum were tried in 1913, 1914, and 1915, to determine their value for silage and grain production. On account of decided unevenness of soil conditions due to grading, only small areas could be devoted to each variety and have them all under similar conditions. The tests ranged in

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[1] Allen, R. W. Vegetable tests on sandy soil at the Umatilla Experiment Farm. Oreg. Exp. Sta. Bul. 136, 38 p., 9 fig. 1916.

Allen, R. W. The work of the Umatilla Experiment Farm for the year 1912. *In* U. S. Dept. Agr., Bur. Plant Indus. Cir. 129, pp. 21–32, 4 fig. 1913.

Allen, R. W. 1914, op. cit.; 1915, op. cit.

extent from single rows 150 feet long to plats of one-tenth of an acre. Twelve varieties of corn and eight of sorghum have been grown. The yields in pounds per acre of corn harvested at the stage of maturity suitable for silage are given in Table XVI.

TABLE XVI.—*Yields of corn in a variety test at the Umatilla Experiment Farm in 1913, 1914, and 1915.*

Variety.	Yield per acre (pounds).		
	1913	1914	1915
Carson	.....	8,678	.....
Disco White Dent	6,406	10,757	.....
Leaming	5,701	10,026	[a] 6,828
Leaming, U. E. F.[b]	.....	8,437	.....
Minnesota King	.....	12,738	.....
Minnesota No. 13	6,033	8,869	[b] 5,509
Minnesota No. 23	6,210	8,387	.....
Pride of the North	9,123	14,806	7,800
Reid's Yellow Dent	.....	.....	7,800
Silver King	.....	.....	6,000
Stanford White Flint	7,083	10,950	6,680
Stanford White Flint, U. E. F.[b]	.....	16,235	.....
Stowell's Evergreen	.....	14,837	5,680

[a] Average of two plats. [b] The seed of this variety was produced on the farm the previous year.

The 1914 crop was much heavier than either of the others. Reid's Yellow Dent is very similar in yield to Pride of the North. They also present a very similar appearance in the field. Pride of the North has given the largest yield of green fodder each year during the test and produces a good proportion of grain.

The names of the varieties used, the weight of green fodder, weight of cured stover and grain produced by corn and sorghum varieties in 1915 are shown in Table XVII. The plats ranged from one-twentieth to one-tenth of an acre each in extent.

Of the corn varieties, Pride of the North appeared to produce the most grain in 1913 and 1914, when no records were kept. The yield of all varieties was light. The 1915 results show Silver King to be the best grain variety. Reid's Yellow Dent appears to be as good as Pride of the North. Stanford White Flint and Stowell's Evergreen give large yields of forage, but they do not produce sufficient grain to be desirable for use in the silo. Dakota Amber is the earliest maturing sorghum that has been tried. It is hardy and produces fair yields of grain that matures uniformly and does not shatter.

Feterita is desirable on account of its heavy growth and good proportion of grain. The heads are large, the grain is also large, rather soft, and thrashes out well. Its greatest disadvantage is that it is hard to obtain a satisfactory stand of plants. The irregularity of stand is responsible for its not giving larger yields.

TABLE XVII.—*Yields of corn and sorghum in the variety tests at the Umatilla Experiment Farm in 1915.*

CORN VARIETIES.

Variety.	Yield per acre (pounds).			
	Fodder.		Grain on cob.	Shelled grain.
	Green.	Cured.		
Leaming.....average of 2 plats..	6,829	2,516	335	224
Minnesota No. 13.....	5,509	1,375	260	200
Pride of the North.....	7,800	3,200	424	336
Reid's Yellow Dent.....	7,800	3,040	456	324
Stanford White Flint.....	6,680	2,500	204	160
Silver King.....	6,000	2,290	980	760
Stowell's Evergreen.....	5,680	2,100	460	324

SORGHUM VARIETIES.

Variety.	Yield per acre (pounds).		
	Green.	Stover.	Thrashed grain.
Dakota Amber.....average of 4 plats..	10,413	6,944	1,502
Dwarf Blackhull.....do....	8,346	4,308	734
Dwarf hegari.....do....	8,939	4,654	1,401
Feterita.....do....	7,172	3,785	558
Red Amber.....do....	19,658	10,653	1,071
Freed sorgo.....	8,622	4,215	627

Dwarf hegari is a promising variety. From the one trial given it, very good results were obtained, especially in yield of seed. It is short and sturdy and matures rather early.

Dwarf Blackhull kafir produces an abundance of foliage and sets large heads of seed. It matures late and can not be grown to advantage on this account.

Red Amber has been tried but once, with unusually large yields of forage. It gave the best stand of any variety of sorghum in 1915 under identical conditions with feterita, Dwarf Blackhull, Dwarf hegari, and Freed sorgo that produced less than one-fourth enough plants to make a satisfactory crop. The growth was very tall and slender with a small number of leaves. It is desirable in some respects and should be more generally tried.

Sudan durra was tried once, with fair results, but it was small and matured late.

Brown kaoliang is not a desirable variety. The stalks are tall and slender, with few narrow leaves and a small amount of small seed.

Freed sorgo grew well, the heads ripened unevenly, and the seed shattered as soon as ripe. Some heads did not fill.

The average yield of green forage, stover, and grain produced by the grain-sorghum varieties has been much above that of corn. This is especially true when they are put on new land.

For new land and coarse land without a high water table, Dakota Amber sorghum and Dwarf hegari are much more desirable than corn. For productive land corn is best, as it produces large crops of forage which mature evenly, it can be planted to cultivate both ways, and good stands are usually secured.

The principal difficulty met with in growing grain sorghum is the factor or factors causing unsatisfactory results in getting a uniform stand. Almost a perfect stand of corn was secured from seed sown under identical conditions with sorghum varieties that came up rather poorly. The poor stands of grain sorghum appear to be influenced by depth of seeding, temperature, and moisture conditions of the soil, but this has not been finally determined.

The length of the growing season is a factor of importance in the production of corn and grain sorghum. Quick-maturing varieties require less irrigation water and less labor in irrigating than late varieties. They can frequently be used to advantage to follow such early crops as potatoes and field peas.

SUDAN GRASS.

The yields of Sudan grass hay in 1916, field A2, varied greatly as a result of differences in the frequency of irrigation. The yield of six plats, three in rows and three sown broadcast, one of each irrigated at intervals of one, two, and three weeks, respectively, is shown in Table XVIII.

TABLE XVIII.—*Yield of Sudan grass in rows and in a thick stand with different frequency of irrigation, at the Umatilla Experiment Farm in 1916.*

Method of seeding.	Calculated yields of cured hay per acre (pounds).		
	Irrigated once a week.	Irrigated once in 2 weeks.	Irrigated once in 3 weeks.
Rows 36 inches apart	1,500	2,800	3,000
Thick stand	2,200	2,300	3,900

The plat on which the thick stand was irrigated once in three weeks was partly covered with manure, which caused a vigorous growth. Irrigation once a week was too often for the cool season, and the plats irrigated once in three weeks suffered somewhat from drought. From this is appears that Sudan grass should be irrigated at intervals of about 14 days on sandy soil. When properly handled, good crops can be expected.

Sudan grass sown broadcast and in rows 3 feet apart did well under both conditions in 1915. That in rows grew ranker than the thick stand and made coarser feed. One-tenth acre of the rows was

cut between July 18 and 30 and fed green. A good second crop came on and produced some seed. It was as tall but not as thick as the remainder of the plat at the close of the season.

The part from which one crop was taken produced cured hay at the rate of 2,228 pounds per acre. Of this, 1,728 pounds were straw and 500 pounds seed. The second crop on the area, cut in July, yielded 1,757 pounds of forage per acre, which when thrashed gave 1,620 pounds of straw and 137 pounds of seed.

When grown for forage alone, Sudan grass should be cut at least twice in one season. The hay is better if harvested in two cuttings, as the percentage of ripe straw is not as great as when it is allowed to mature. The greatest value of Sudan grass in this district, however, is for green summer feed for dairy cattle. It has been grown under a variety of soil and moisture conditions on the project with uniformly satisfactory results.

COOPERATIVE TESTS OF SUDAN GRASS AND GRAIN SORGHUM.

In 1916, samples of Sudan grass, Dakota Amber sorghum, Dwarf hegari, and feterita seed, which was taken from the variety test of these crops in 1915, were distributed to farmers on irrigated and nonirrigated lands of eastern Oregon. Eighty-eight samples were sent out, divided as follows: Sudan grass, 27; Dakota Amber sorghum, 21; Dwarf hegari, 12; feterita, 28. Notes on the success of 45 tests were received, which were divided as follows: Sudan grass, 14; Dakota Amber sorghum, 11; Dwarf hegari, 7; feterita, 13. The reports submitted give results of 32 tests on irrigated land, which was mostly of a coarse, sandy nature, and 13 on dry land, a fine sandy loam having from 11 to 14 inches of rainfall. Cool spring weather prevailed and appeared to be responsible for generally poor stands of plants, slow growth, and late maturity of the crops. Frequent winds which occurred while the plants were small severely injured several of the tests on coarse soils.

Although few of the tests of Sudan grass were successful under irrigation, the farmers who tried it, being aware of the hardships it had, were fairly well pleased. They all recognized its value to take the place of alfalfa as a soiling crop for use by dairymen. It did very well on the dry farms. Satisfactory crops of forage and seed were produced in most of the tests. Its value for hay and silage or as a seed crop was also recognized, and several farmers expect to try it again with the intention of giving it a permanent place in their regular cropping system.

Dakota Amber sorghum and Dwarf hegari gave better results under irrigated and nonirrigated conditions than feterita. On account of the large size of the feterita it appears to be preferred by

the irrigation farmers, but the dry-land farmers favor Dakota Amber sorghum and Dwarf hegari. Feterita does not mature early enough on dry land and suffers more from drought than the other two crops. These varieties of sorghum appear to suit the needs of irrigation farmers on coarse and new soils better than corn, but are not so productive on richer land. They did very well under rather unfavorable conditions and attracted the attention of a number of farmers who desire to try them thoroughly and to learn whether they can be used to advantage.

JAPANESE SUGAR CANE, TEOSINTE, AND OTHER FORAGE CROPS OF MINOR IMPORTANCE.

Row tests of Japanese sugar cane, teosinte, and broom corn were made in 1914. The sugar cane was propagated from stalks sent by mail from San Antonio, Tex., the previous fall and kept over winter under a mound of earth. It was planted in plow furrows and came up slowly. A few of the largest plants reached a height of 4 feet. It was not warm enough here for this crop.

A good stand of teosinte was secured, but growth was very slow. The plants stooled extensively, sending out so many small shoots that they presented more the appearance of grass than of sorghum. The maximum height was 1½ feet. It is not adapted to this climate.

The average height of the broom corn was 6½ feet and the maximum 8 feet. The brooms varied greatly in character, but some of them were of good quality. The plants stooled out well and made a strong growth. The percentage of good brooms was low and evidently could be greatly increased by careful seed selection. As there is no local demand for broom corn it has little commercial importance.

Two varieties of millet, German and New Siberian, were planted in 1909 on newly graded land. The stand and growth were poor. Although it was sown late (July 13) some seed matured and shattered out. It became a serious pest for several years. Millet grows fairly well on moist soil, but does not do well on new land. Since there are many better crops, it should not have a place on the irrigated farms of this district.

Approved:

WM. A. TAYLOR,
Chief of Bureau.

AUGUST 18, 1917.

OTHER PUBLICATIONS OF THE UNITED STATES DEPARTMENT OF AGRICULTURE OF INTEREST IN CONNECTION WITH THIS CIRCULAR.

AVAILABLE FOR FREE DISTRIBUTION BY THE DEPARTMENT.

The Work of the Belle Fourche Reclamation Project Experiment Farm in 1916. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 14.)

The Work of the Huntley Reclamation Project Experiment Farm in 1916. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 15.)

The Work of the Truckee-Carson Reclamation Project Experiment Farm in 1915. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 13.)

The Work of the Umatilla Reclamation Project Experiment Farm in 1914. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 1.)

The Work of the Yuma Reclamation Project Experiment Farm in 1915. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 12.)

The Work of the Scottsbluffs Reclamation Project Experiment Farm, 1915. (Bureau of Plant Industry Miscellaneous Document. W. I. A. Circular 11.)

Establishing the Swine Industry on the North Platte Reclamation Project. (Bureau of Plant Industry Miscellaneous Document. D. R. P. Circular 1.)

Sugar-Beet Growing under Irrigation. (Farmers' Bulletin 567.)

Grains for the Dry Lands of Central Oregon. (Farmers' Bulletin 800.)

Experiments in the Production of Crops on Alkali Land on the Huntley Reclamation Project, Montana. (Department Bulletin 135.)

Experiments with Spring Cereals at the Eastern Oregon Dry-Farming Substation, Moro, Oreg. (Department Bulletin 498.)

FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, GOVERNMENT PRINTING OFFICE, WASHINGTON, D. C.

Irrigation of Alfalfa. (Farmers' Bulletin 373.) Price 5 cents.

Potato Culture on Irrigated Farms of the West. (Farmers' Bulletin 386.) Price 5 cents.

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Bean Growing in Eastern Washington and Oregon and Northern Idaho. (Farmers' Bulletin 561.) Price 5 cents.

Report of Irrigation Investigations in California. (Office of Experiment Stations Bulletin 100.) Price $1.25.

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The Work of the Umatilla Experiment Farm in 1912. (In Bureau of Plant Industry Circular 129.) Price 5 cents.

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